sidereal time. A modified and improved instrument, devised by my assistant, Mr. Edward E. Robinson, adds a sighted pointer to the dial, this pointer being moved by hand to the right date; and the clock may then keep ordinary time. The dial is geared down 1 : 24, and driven by the minute hand, so as to be under the ordinary control of clock-regulation. In each instrument a one-day hand-shift is needed every 29th February.—(3) Resonant Leyden jars. A couple of independent but similar Leyden jar circuits arranged at a moderate distance from each other, the self-induction or capacity of one of them being adjustable, with an easy overflow path. On discharging one of the jars, the other resounds and overflows, being provided with an easy overflow path. The oscillations are much more numerous than with ordinary linear (Hertz) vibrators, and therefore some precision is demanded in the tuning.

Self-recording instruments, exhibited by MM. Richard Frères.

Method of recording pyrometric measurements at temperatures between 600° C. and 1200° C., exhibited by Prof. Roberts-Austen, C.B., F.R.S. The apparatus is that employed in a research undertaken for the Institution of Mechanical Engineers, and is used for automatically recording, by the aid of photography, the indications of a platinum and platinum-rhodium thermo-couple. The experiments shown illustrate a method of recording the rate of cooling of heated masses of metal. Curves are shown to illustrate the kind of results which are obtained by the aid of the apparatus.

Length-measuring instrument, exhibited by Prof. W. C. Unwin, F.R.S. In ordinary screw or vernier micrometers the straining of the instrument alters the readings, and in using the instrument much depends on personal skill. In this instrument the contact is with fixed pressure, and independent of feeling. Delicate levels show when the instrument is adjusted.

Portraits of deceased astronomers and physicists, exhibited by Mr. W. B. Croft.

Mr. Killingworth Hedges exhibited:—(1) Electrical safety-valve.—(2) Exhausted bulbs, used to ascertain the space traversed by high tension alternating currents. The electrical safety-valve is designed for attachment to low pressure service lines, in order to prevent their being charged at a dangerous difference of potential from the earth. The glass bulbs were exhausted to different pressures, and fitted with electrodes of various forms, in order to ascertain if an arc could be started with an E.M.F. of 300 volts, which is the limit of potential fixed by the Board of Trade for currents of low pressure.

Focometer, exhibited by Prof. Silvanus P. Thompson. By this instrument can be determined the position of the two principal "focal planes" and of the two "principal planes" of Gauss, for any compound system of lenses, such as a microscopic objective or the lens of a photographic camera; thus giving the true focal length, and the positions and distance apart of the two virtual optical centres of the lens-system. The principle applied is that of finding directly the two principal foci, and then, by means of a right-and-left-handed screw, moving two micrometers placed at these foci to the two symmetric points where each micrometer coincides with the image of the other. The displacement so given by the screw is equal to the true focal length.

Mr. Shelford Bidwell, F.R.S., exhibited: (1) Selenium cells, the electrical conductivity of which is greater in the light than in the dark. (2) A selenium lamp-lighter, lighting an incandescent lamp automatically when darkness comes on. (3) A selenium alarm, for calling attention to the accidental extinction of a ship's light or railway signal lamp.—Mr. W. Crookes, F.R.S., exhibited electricity and high vacua.—Mr. G. J. Symons, F.R.S., exhibited photographs of damage produced by the tornado of August 18, 1890, at Dreux (Eure et Loire), France.—Prof. C. Piazzi Smyth exhibited examples of photographic enlargements of the solar spectrum, each magnified from the original negative from 25 to 27 times linear.—Mr. George Higgs exhibited photographs of the normal solar spectrum.

M. G. Lippmann exhibited colour photographs of the spectrum:—(1) Small spectrum, exposure about 3 minutes.—(2) Large spectrum, exposure about 6 minutes, without coloured screens. The colours seen on these plates are produced by the direct action of light; they are not due to any pigments, the substance of the films remaining colourless, but are of the same kind as the colours of soap-bubbles and mother-of-pearl, viz. interference phenomena; they are due to the structure imparted to the film by the stationary waves of incident light during exposure in the camera. These colours are perfectly permanent.

Prof. A. Schuster, F.R.S., exhibited some forms of Clark cells.

Prof. Emerson Reynolds, F.R.S., exhibited: (1) Specimens of tetrathiocarbamid-ammonium bromide, $(H_5N_2CS)_4NBr$, and related substances. (2) Series of photographs illustrating the application by Colonel Waterhouse of the above bromide to the reversal of the photographic image on gelatino-bromide of silver films.—Mr. W. Saville-Kent exhibited photographs of living corals, taken in Torres Straits.—Dr. W. Hunter exhibited a series of ptomaines—alkaloidal products formed by bacteria from animal tissues.—The Committee of the Camera Club exhibited allotropic forms of silver, prepared by Mr. Carey Lea, of Philadelphia, and described in *Amer. Journ. of Science* for 1889, and *Phil. Mag* for 1891.—Prof. G. F. Fitzgerald, F.R.S., exhibited crystals of platinum and palladium (prepared Mr. J Joly).—Prof. J. A. Ewing, F.R.S., exhibited Prof. Sekiya's model of a Japanese earthquake.—The Council of the Royal Society exhibited a cabinet containing medals struck in honour of Fellows of the Royal Society.—Mr. Edward Schunck, F.R.S., exhibited indigo-blue and allied substances and derivatives of chlorophyll.—Mr. Fred Enock exhibited microscopic preparations of the British Mymaridæ (egg parasites).—Dr. H. Woodward, F.R.S., exhibited skull and shoulder-girdle of *Procolophon trigoniceps* (Owen), collected by Dr. Exon in the Orange Free State (figured Phil. Trans., 1889, p. 267).—Mr. J. Howard Mummery exhibited specimens illustrating some points in the structure and development of dentine.—Mr. Allan Dick exhibited a new form of polarizing microscope.

Meteorological photographs, exhibited by Mr. Arthur W. Clayden. The photographs of clouds have been taken by reflection from a mirror of black glass, placed in front of the camera, so that the plane of its surface makes the polarizing angle with the axis of the lens. Those of hoar-frost show how the crystals attach themselves to the projecting portions of objects, such as the margins of leaves, the loose fibres of a string, and the thorns of a briar, and also their tendency to grow towards the direction from which the air has been moving.

THE BENUÉ AND THE KIBBÉ.

At Monday's meeting of the Royal Geographical Society, Major Claude M. Macdonald, H.M. Commissioner to West Africa, gave an account of a journey up the Benué and its northern tributary the Kibbé, in the summer of 1889. The Benué, we need scarcely say, is the great tributary of the Niger. Major Macdonald referred to the previous explorations of Barth and others, and to the fact that it has been maintained that a connection existed between Lake Chad and the Benué, by the overflow of the Shari on one side and the Kibbé on the other. Major Macdonald has been the first to explore the Kibbé. After describing the ascent of the Benué, Major Macdonald went on to say that he and his party started on their journey up the Kibbé in the Royal Niger Company's stern-wheeler the *Benué*, on August 21.

The Kibbé at its mouth is some 250 yards wide, while the Benué is upwards of 600. The average depth of the Kibbé at this season of the year, nearly high water, is from 10 to 12 feet. On both banks for the first five miles the country is flat and well wooded, with patches of bright green grass, and looks very gamey, though owing to the high grass we saw no deer. A noticeable feature some five or six miles from the river is Mount Katie, a rounded hill, some 800 feet high, well wooded to its summit. This hill, from its isolated position, served as an excellent point on which to take angles for mapping purposes. Patches of cultivation were now to be seen on both banks, and after two hours' steaming the party passed the Fulbe village of Dinghi. The inhabitants, though they had never before seen a steamer or a white man, did not seem much disconcerted, and, when shouted to in their language, returned the salutations in a very friendly manner. On August 22 the *Benué* anchored off a large village on the left bank. "We very soon saw," Major Macdonald states, "that we had to deal with the purest-bred Fulbe we had seen so far. The crowd consisted almost entirely of women—by far the best-looking we had as yet seen on the Niger, and indeed the best-looking I have seen in either east or west Equatorial Africa. They wore the usual piece of cloth wound round their bodies, leaving their arms and shoulders bare, and reaching down below the knee. Their features, in most cases, approached the European, and their expression most

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gentle and modest, yet full of vivacity. They told us that the name of their village was Pamu, and that it was governed by an Emir, who was under the jurisdiction of the Emir of Yola. The men were armed with spear and bow and arrows, though they are said to be an agricultural people, and certainly it would seem so, for every yard of ground in the neighbourhood of Pamu was under cultivation. We asked them if they would bring us provisions in exchange for cloth ; this they readily did, and we soon were hard at it, bartering pieces of cloth, salt, &c., for live stock, weapons, ornaments, and indeed anything. The whole time nothing but the greatest good temper prevailed, and I was much struck by their gentleness and courtesy ; albeit the ladies were very good at a bargain, and I noticed that when it came to bartering their ornaments, members of the fair sex, who were not so young or so fair as their more fortunate sisters in this respect, surreptitiously handed their ornaments to the latter to dispose of, hoping thereby to get better value, and I am bound to confess they did."

Shortly after this the steamer came to a deserted strip of country, some fifteen miles in length, which was evidently the barrier between the Mahommedan and Pagan tribes; it was of an undulating character, with isolated hills, and well wooded. The river was still about 100 yards wide, but commenced to be dotted with grassy islands, and was in parts very shallow with a sandy bottom.

Next day, as the steamer advanced, the river narrowed again and made a sharp bend to the eastward, and approached a grassy range of mountains, leaving a higher range to the north. Half an hour after starting the party arrived at the foot of the grassy slopes of the former; a pathway, which could be traced for a considerable distance, wound up the face of the mountain and disappeared over one of its grassy ridges. Patches of cultivation could be seen dotted here and there ; the main valley stretched back some three or four miles, but we could see no signs of a village.

"We were, however," Major Macdonald stated, "not left long in doubt as to whether the country was inhabited or not, nor as to the character of the inhabitants, for down the winding path, which was distant some 600 yards from where we were, came a line of warriors, some 200 in number ; the majority of them were quite naked, though some few had a small cloth round their waists. They were all armed, mostly with spears, the almost invariable number being three. Leaving the pathway, they advanced in excellent order across the boulder-covered grassy piece of ground which lay between the river and the mountain side. We accordingly moved into mid-stream, which was only some 15 yards from the bank, and dropped anchor in about 4 feet of water. Our friends advanced straight at us, not a word being spoken, but an excellent line being maintained, when suddenly they all took cover behind boulders and tufts of grass, nothing being visible but the gleaming points of their spears. It was a source of some gratification to us that the points were gleaming, for it showed that at any rate they were not poisoned. There was now a pause. Then our Fulbe interpreter, under my directions, opened fire in a dialect of the Battawa, with satisfactory results, for they appeared to understand him. Their first question was as to whether 'we were Mahommedans? because if so we could not pass, as they were the outposts of the Pagan tribes, and had orders not to allow Mahommedans to pass.' We assured them that we were not Mahommedans. They then told us, in answer to our queries, that the name of their village was Katsho, and that it lay back from the river amongst the hills ; they said that if we went on we would come to more villages. After a great deal of persuasion two of their number consented to come on board. So we sent a six-oared gig, which we had towed up with us in case of accidents, to fetch them. They were fine, well-made men, but were trembling with fright at the sight of the steamer and white men, and prostrated themselves on the deck at our feet. These two men wore loin cloths of native manufacture ; the great majority of the others were, as I have said, naked. After getting as much information out of these men as we could, which information, on account of their terror and the difficulty in interpreting, was somewhat meagre, we proceeded on our way. By this time large numbers of men and boys had assembled, and ran along the banks gesticulating and pointing at our little ship. They, men and boys alike, were all armed, mostly with spears ; we saw very few bows and arrows.

"The scenery now was very picturesque ; to our right, *i.e.* the south of the river, some few yards from the water's edge, the mountains rose in some places quite abruptly. These mountains were for the most part covered with green wavy grass very pleasant to the eye. One or two streams trickled down the mountain side, forming now and again picturesque waterfalls. The river had suddenly broadened out to a lake, or, more properly speaking, marsh, some three miles long by two wide. The range of grassy mountains I have mentioned ran along the southern shores of the lake and terminated with it. The country on the east and north shores of the lake, as far as the eye could see in the direction of the Tuburi marsh (near the Shari river) was open and gently undulating, while from the western shores of the lake the beautiful range of mountains, with their needle-shaped peaks, stretched back apparently for many miles. In the north-east corner of the lake we saw a very large village some two miles distant ; this we afterwards ascertained was Bifaré. The channel of the river evidently followed the base of the southern hills. We accordingly steamed gaily along, followed on the shore by an ever-increasing crowd, till we arrived at a large village prettily situated almost on the edge of the lake. The houses or huts were built in clusters, each cluster apparently belonging to a different family. The huts were very well constructed, having round walls some 6 feet high, with flat roofs formed by beams covered over with mud and thatch. The walls of the huts were made of black and in some places red mud, and the workmanship of both walls and roof was excellent. Several hamlets were prettily situated on the slopes of the hill, surrounded with patches of cultivation, and had the appearance of the country places of the richer inhabitants of the village.

"A large crowd had now assembled, and regarded our movements with great curiosity. We asked to see the chief of the village, and after a good deal of palaver, a man appeared attired in a very tattered 'tobe' or gown. He had something of the Fulbe in his countenance, and was a tall fine man, though of rather a forbidding appearance. He came on board, and we endeavoured to get what information we could out of him. He said the name of the big water we saw was Nabaret, but that it was only a fourth that size in the dry season. The name of his village was Kaku. The channel of the river ran along by the mountains. He knew of the Tuburi marsh, but had never been there ; he did not think the river came from there as it was distant many days' journey. He knew of no other big water, but would give us a guide to show us the way. The people of the Nabaret district are possessed of cattle, but no horses ; they live principally on dhurra, which they cultivate largely, and on fish which abound in the lake. They also hunt the hippopotami, of which we saw a dozen in the lake, though doubtless there may be many more.

"We took our guide on board and endeavoured to make for Bifaré, already mentioned, which appeared to be a village of quite 6000 inhabitants, situate on the north-east shores of the lake, and distant some two miles from where we were. After proceeding about 100 yards we found that the water shoaled about a foot, and even less, and though we made every effort to proceed, we were completely baffled ; turning back, by direction of the guide, we went for an opening in the high dhurra, which grew in immense quantities about here, and found ourselves once more in the channel of the stream, which was, however, only some 8 yards wide and 2½ feet deep, flowing with a swift current. After proceeding with great difficulty for almost a mile, with fields of dhurra growing to a height of 8 feet on either side and completely shutting out the view, the navigation became so difficult that we had to turn back, having already smashed in the bow of our gig, bent our rudder into the shape of a bow, and more than once berthed our little ship amongst the dhurra stalks. The stream was so narrow that we could not turn, but had to float down backwards for a good half mile. The highest point reached was a mile and a half from the village of Kaku, and from what the people said, a good thirty miles from Dawa, in the Tuburi country, the furthest point reached by any European entering Africa from the north, viz. Dr. Vogel in 1854. The stream at the point where we reluctantly turned back was not more than 2 feet deep, and from 15 to 20 feet wide, and this at the period of high water. I should say that in the dry season (and this is corroborated by the natives themselves) that a man could step across it. It is more than probable, therefore, that had we been able to proceed another three miles or so, we should have arrived at its source."

It seems evident, then, from Major Macdonald's observations, that no connection can exist between the Shari and the Benué.

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